

## ENGLISH TRANSLATION DOCUMENT

The following attached document is the English Translation Document for the  
below referenced Chinese patent application.

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Application Type: Invention

Title: Automobile Exhaust Muffler and Purifying Devices

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Attorney Docket: BYD-US2003-003

Translation Certification

I hereby certify that the following translation of the respective certified copy is

correct.



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## Abstract

This utility model relates to a type of automobile exhaust purifier muffler device, including a metal outer shell. The two ends of the outer shell are separately connected to the intake and outtake pipes. The outer shell contains sound absorption and purifying material made from porous material. The pore diameter is between  $5\mu\text{m}$  and  $1200\mu\text{m}$  and the pore density is between 80% and 98%. A catalytic coating layer is attached to the surface of said porous metal material. The construction of this type of exhaust muffler device is simple. It is easy and simple to manufacture and the cost of production is low. It can withstand high temperature, is resistant to corrosion and the impact from air flow such that its useable life span is long.

## Description

### Automobile Exhaust Muffler and Purifying Devices

#### Field of Invention

This utility model relates to a type of automobile exhaust muffler and purifying  
5 devices. More particularly, it relates to a type of automobile exhaust purifier muffler  
device that uses porous metal as its sound absorption material and the material for the  
substrate of the catalyst.

#### Background of Invention

10 The severity of environmental contamination from exhaust and exhaust noise of  
the engine is commonly known. To purify automobile exhaust and control external  
exhaust noise, it is common to use purifiers and mufflers that are mutually separate and  
have separate construction. This type of separate structure not only causes a decrease in  
engine efficiency, but also increases the installation cost and the cost of production.

15 Ceramic and metal are the two materials used for the substrate of existing  
automobile exhaust purifiers. When compared with metal substrates, the disadvantages

of the commonly used honeycombed ceramic substrates include: they generally operate at lower temperatures (soften at 1400°C); their walls are thicker, they preheat slower, and their exhaust pressure is higher. As such, many countries are conducting research on metal substrates. The wall of a metal substrate is only  $\frac{1}{4}$  as thick as the ceramic substrate wall. Therefore, exhaust pressure can be lowered and the substrate for the catalyst can also be made smaller. Metal substrates have a small heat capacity and as such it can be preheated efficiently. Therefore metal substrates have the advantage that the catalyst can be electrically preheated to realize the implementation of the zero emission policy for hydrocarbons. It also has the advantage of adapting well to temperature changes. Existing metal substrates of automobile exhaust catalytic converter mainly use combinations of various structure of corrugated metal. Their resistance to heat and mechanical impact are lower. Especially at high temperatures, their anti-oxidation ability is insufficient, thereby affecting the automobile exhaust catalytic converter's useable lifespan. In addition, comparatively, the specific surface area of this type of corrugated metal substrate is limited and their capability for the active ingredient of the catalyst to be adsorbed is insufficient, thus limiting the

capability to further improve the efficiency for purification of the automobile exhaust catalytic converter

Existing automobile exhaust muffler system customarily use reactive type sound absorption devices because these system are constructed of metal construction, with

5 simple structures that can withstand high temperature, corrosion, impact from air flow, and have a long lifespan. However, the spectrum of sound absorption of these reactive type muffler devices is narrower with better results in the low frequencies and worse in the high frequencies. In order to compensate for the weakness in high frequency sound absorption and achieve sound absorption for the automobile exhaust system, structures

10 such as multi-stage combinations, i.e., multi-stage mufflers or dissipative and reactive combination style mufflers are often needed for better results in high frequency sound absorption. However, these methods increase the complexity of the technology and increase the cost for sound absorption.

Existing sound absorption materials commonly use woven aluminate felt blanket

15 and asbestos felt that can usually resist high heat and corrosion. They are then firmly secured to a securable surface protecting structure. These mufflers' ability to resist

impact, humidity, and dust are relatively low resulting in comparatively short useable life spans. At the same time, their sound absorption capability is also relatively low. Therefore, at present, they are not widely used in the automobile industry.

#### 5 Description of Utility model

This utility model relates to a type of automobile exhaust purifying and sound muffling device that can withstand high temperature, corrosion, and impact from air flow. It has a long life span as well as good exhaust purifying and sound absorption characteristics. It is also simply constructed and easy to fabricate.

- 10        This utility model comprises of a metal outer shell where the two ends of the outer shell are respectively connected with the intake and outtake pipes. The outer shell holds purifying and sound absorption device parts. Said device is a substrate with multiple pores. At least part of the substrate is made from porous metal with pore diameters between 50 $\mu$ m and 1200 $\mu$ m and pore density between 80% and 98%. (Pore
- 15    density is the ratio of the volume of the pores with the volume of the total material \* 100.) A coating of catalyst is attached to the surface of the porous metal material.

Said porous metal can be placed in sections perpendicular to the direction of the airflow, with an air gap between the sections. Said porous metal can also be placed either in single or multiple layers in the direction parallel to the direction of the air flow, leaving gaps between the layers of porous metal, and between the inside of the outer shell and the layers of porous material. The thickness of said porous material is between 10mm and 40mm and the thickness of gap or gaps is between 10mm to 50mm.

Said porous metal material includes the porous form of nickel, iron, copper, aluminum, titanium and other alloy.

The composition of the catalyst coating includes metal elements, rare earth metals and small quantities of precious metals. The metal elements include one or more of the following: calcium, Ca, barium, Ba, magnesium, Mg, zirconium, Zr, zinc, Zn, and aluminum, Al. The rare earth metals include one or more of the following: cerium, Ce, lanthanum, La, praseodymium, Pr, and neodymium, Nu. The precious metals include one or more of the following: palladium, Pd, platinum, Pt, rhodium, Rh, and ruthenium, Ru.

One of more of the following can also be added as a component for said catalyst coating:  $\gamma$  oxides of aluminum, oxides of zirconium, and oxides of cerium.

This utility model is constructed simply and easy to fabricate. It has a long useable life span as well as good exhaust sound absorption characteristics in a wider frequency spectrum. It can also withstand heat and mechanical impact. Its specific surface area is large and it purifying efficiency high.

#### Description of Drawings

Figure 1 is a diagram of the structure of the first embodiment of the automobile exhaust purifying and sound absorption device of this utility model.

Figure 2 is a diagram of the structure of the second embodiment of the automobile exhaust purifying and sound absorption device of this utility model.

Figure 3 is a structural diagram of the embodiment in Figure 2 as viewed from the direction of "A".

Figure 4 is a diagram of the structure of the third embodiment of the automobile exhaust purifying and sound absorption device of this utility model.

Figure 2 is a diagram of the structure of the fourth embodiment of the automobile

exhaust purifying and sound absorption device of this utility model.

The following refers to the attached figures showing embodiments and explains this invention in further detail.

5

#### Particular Implementation Methods

##### Embodiment 1

Figure 1 shows an embodiment that includes an outer metal shell (2). The two ends of the outer shell (2) are separately connected with the intake pipe (2) and the

10   outtake pipe (4). (Securing flanges can be inserted on the intake and outtake pipes.)

The outer shell (2) holds the sound absorbing material made of porous metal (3). The

relative density of the porous metal can be between 80% and 98%. The pore diameter

can be between 50 $\mu$ m and 1200 $\mu$ m. A coating of catalyst is attached to the surface of

the porous metal. The sound absorbing material (3) is in sections and placed

15   perpendicular to the direction of the airflow inside the outer shell (2). (The figure shows

two sections. In practice, multiple sections can be used.) Gaps are left between the

sections of sound absorption material. The thickness of the sections of sound absorbing material can be between 10mm and 40 mm. The thickness of the gap can be between 10mm and 50mm.

Said porous metal can include the following: metal elements of nickel, iron, or titanium or alloys formed by above said metals. It can also be an AB type alloy where the A component is one of the following: nickel, iron, or titanium and is 55 wt.% to 95% wt.% of the porous metal material. The B component is 5wt.% to 45 wt.% of the porous metal material and contains one of more of the followings: chromium, Cr, aluminum, Al, cobalt, Co, molybdenum, Mo, and zinc, Zn.

The composition of the said catalyst coating includes metal elements, rare earth metals and small quantities of precious metals. The metal elements include one or more of the following: calcium, Ca, barium, Ba, magnesium, Mg, zirconium, Zr, zinc, Zn, and aluminum, Al. The rare earth metals include one or more of the following: cerium, Ce, lanthanum, La, praseodymium, Pr, and neodymium, Nu. The precious metals include one or more of the following: palladium, Pd, platinum, Pt, rhodium, Rh, and ruthenium, Ru.

One of more of the following can also be added as a component for said catalyst coating: γoxides of aluminum, oxides of zirconium, and oxides of cerium.

The size of the pore diameter of the porous metal greatly affects the characteristics of the exhaust purification. When the pore diameter is between 50μm and 1200μm, the  
5 conversion results are better. The conversion results are the best when the pore diameter is between 400μm and 800μm. At the same time, the size of the pore diameter of the porous metal also greatly affects its sound absorption ability. The sound absorption coefficient increases as the pore diameter increases exhibiting a trend to first increase from low to high and then decrease from high to low. The best results for sound  
10 absorption are obtained for pore diameters between 200 and 1200. At the same time, the sound absorption results are better at high frequencies than low frequencies.

Therefore, methods such as leaving gaps between the sound absorption material and reasonably increasing the thickness of the material are used to improve the sound absorption characteristics, especially those at the lower frequencies. Theoretically, gaps  
15 can also have the effect of increasing the material's thickness. This is equivalent to increasing the effective length of the capillaries. This will decrease the use of materials,

lower cost, and improve the material's sound absorption properties, especially at the lower frequencies. Research proves that, especially at lower frequencies, sound absorption increases when the thickness of the porous material is between 10mm and 40 mm., and the size of the gap is between 10 mm and 50 mm., thus allowing this utility

5 model to obtain good sound absorption in a wide spectrum of frequencies.

The pore density of the porous metal material significantly affects the specific surface area of the substrate that the catalyst is attached to, the purification and sound absorption characteristics, and the air resistance. However, if the pore density of the material is increased to above 98%, not only would the technology be more difficult, but

10 it would be uneconomical and affect the mechanical strength of the material and lowering its ability to resist impact. Therefore, the best specification is to limit the pore density of the porous material to be between 80% and 98%.

### Embodiment 2

As Figures 2 and 3 show, the porous metal material used is set parallel to the

15 direction of the air flow. Air flow passages are also formed between the sound absorption material (3) made from porous metal and between the sound absorption

material (3) and the metal outer shell (2). In this way, the resistance of the exhaust from the engine is smaller but the sound absorption results are also slightly lowered. The quantity of the porous metal material (3) in this design can be a single layer or multi-layers with gaps between the layers of the porous material and between the porous material and the walls of the outer shell. The best specification is for the thickness of the porous metal to be between 10mm and 40mm and the thickness of the gap to be between 10mm and 50mm.

#### Embodiment 3

As shown in Figure 3, the front half section inside the outer metal shell (2) uses porous metal (3) as the sound absorption material, while the back half section uses corrugated metal (5) as the metal substrate for the catalyst. Everything else is the same as embodiment 1.

#### Embodiment 4

As Figure 5 shows, this embodiment places sections of porous metal (3) between sections of corrugated metal with catalyst attached (5) inside the metal outer shell (2),

with gaps (6) placed between each section. Everything else is the same as embodiment

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Testing of the above said embodiments of this utility model of an exhaust

purifying and sound absorption device in common sedans shows that exhaust

5 purification results and sound absorption characteristics all exceed national standards.

Above said embodiments are preferred implementations of the fundamental ideas

of this utility model. Persons having ordinary skill in the field of this invention can

make some changes to certain parts of this invention to implement the theory of this

utility model; however, they all still remain in the realm of protection by this utility

10 model.

## Claims

1. A type of automobile exhaust purifier muffler, including a metal outer shell

where the two ends of the outer shell are respectively connected with the intake and

outtake pipes. The outer shell holds purifying and sound purifying device parts. Said

5 equipment is a substrate with multiple pores. Its characteristics are: at least part of the

substrate is made from porous metal with pore diameters between 50 $\mu$ m and 1200 $\mu$ m

and pore density between 80% and 98%.

2. Said automobile exhaust purifier and muffler of claim 1, its characteristics are:

10 said porous metal can be placed in sections perpendicular to the direction of the airflow,

with an air gap between the sections.

3. Said automobile exhaust purifier and muffler of claim 2, its characteristics are:

the thickness of said porous material is between 10mm and 40mm and the thickness of

15 gap or gaps is between 10mm to 50mm.

4. Said automobile exhaust purifier and muffler of claim 2, its characteristics are:
- each section of porous metal material can have different pore diameter or pore density.
5. Said automobile exhaust purifier and muffler of claim 1, its characteristics are:
- 5 said porous metal is placed either in single or multiple layers in the direction parallel to the direction of the air flow, leaving gaps between the layers of porous metal, and between the inside of the outer shell and the layers of porous material.
6. Said automobile exhaust purifier and muffler of claim 5, its characteristics are:
- 10 the thickness of said porous material is between 10mm and 40mm and the thickness of gap or gaps is between 10mm to 50mm.
7. Said automobile exhaust purifier and muffler of claim 1, its characteristics are:
- said porous metal material is made from metal element or metal alloy from the
- 15 following: nickel, iron, copper, aluminum and titanium.

8. Said automobile exhaust purifier and muffler of claim 1, its characteristics are:  
  
said porous metal is an AB type alloy where the A component is one of the following:  
  
nickel, iron, or titanium and is 55 wt.% to 95% wt.% of the porous metal material. The  
  
B component is 5 wt.% to 45 wt.% of the porous metal material and contains one of  
5 more of the followings: chromium, Cr, aluminum, Al, cobalt, Co, molybdenum, Mo,  
  
and zinc, Zn.

9. Said automobile exhaust purifier and muffler of claims 1, 7, or 8, its  
  
characteristics are: a catalyst coating is attached to the surface of said porous metal. The  
10 composition of the catalyst coating includes metal elements, rare earth metals and small  
  
quantities of precious metals.

10. Said automobile exhaust purifier and muffler of claims 1 or 7 or 8, its  
  
characteristics are: said catalyst coating contains metal elements that include one or  
15 more of the following: calcium, Ca, barium, Ba, magnesium, Mg, zirconium, Zr, zinc,  
  
Zn, and aluminum, Al; rare earth metals that include one or more of the following:

cerium, Ce, lanthanum, La, praseodymium, Pr, and neodymium, Nu; and precious metals that include one or more of the following: palladium, Pb, platinum, Pt, rhodium, Rh, and ruthenium, Ru.

- 5 11. Said automobile exhaust purifier and muffler of claims 1, or 7, or 8, its characteristics are: one of more of the following can also be added as a component for said catalyst coating:  $\gamma$  oxides of aluminum, oxides of zirconium, and oxides of cerium.

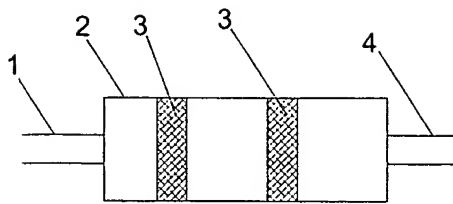


Figure 1

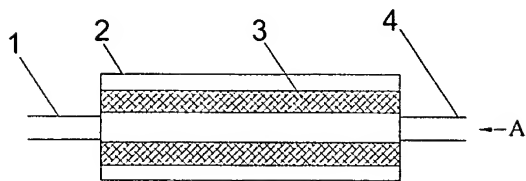


Figure 2

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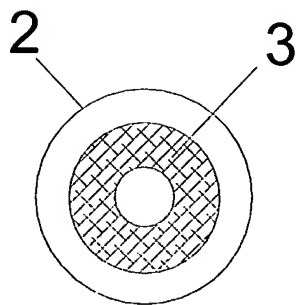


Figure 3

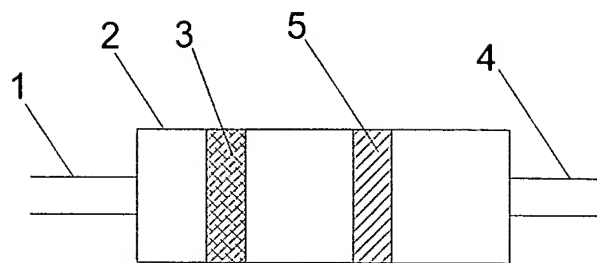


Figure 4

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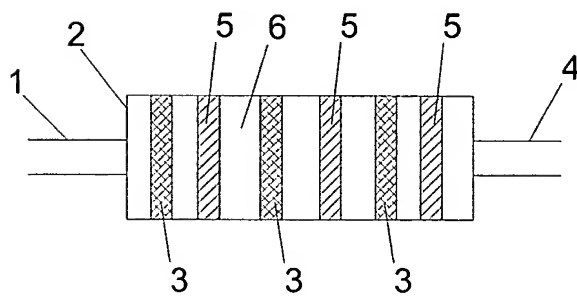


Figure 5